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Indian Standard

SPECIFICATION FOR ELECTRICAL RELAYS FOR POWER SYSTEM PROTECTION

PART 2 REQUIREMENTS FOR PRINCIPAL FAMILIES

Section 2 General Requirements for Measuring Relays

UDC 621·316·925 : 621·318·5 : 620·16

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SPECIFICATION FOR ELECTRICAL RELAYS FOR POWER SYSTEM PROTECTION

PART 2 REQUIREMENTS FOR PRINCIPAL FAMILIES

Section 2 General Requirements for Measuring Relays

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SPECIFICATION FOR ELECTRICAL RELAYS FOR POWER SYSTEM PROTECTION

PART 2 REQUIREMENTS FOR PRINCIPAL FAMILIES

Section 2 General Requirements for Measuring Relays

0. FOREWORD

0.1 This Indian Standard (Part 2/Sec 2) was adopted by the Indian Standards Institution on 28 January 1987, after the draft finalized by the Relays Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard is one of the series of standards being brought out to cover requirements of protection relays. General introduction to this series is given in IS : 3231 (Part 0)-1986*.

The standards published in the series so far are:

IS : 3231 Specification for power systems protection:

(Part 0)-1986	General introduction and list of parts (*first revision*)
(Part 1/Sec 1)-1986	General requirements, Section 1 Contact performance (*first revision*)
(Part 1/Sec 2)-1986	General requirements, Section 2 Insulation tests (*first revision*)
(Part 1/Sec 3)-1986	General requirements, Section 3 High frequency disturbance test for static relays (*first revision*)
(Part 2/Sec 1)-1987	Requirements for principal families, Section 1 All-or-nothing relays
(Part 2/Sec 2)-1987	Requirements for principal families, Section 2 General requirements for measuring relays

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*Specification for electrical relays for power system protection: Part 0 General introduction and list of parts (*first revision*).

(Part 3/Sec 1)-1987	Requirements for particular group of relays, Section 1 Non-specified time or independent specified time measuring relays
(Part 3/Sec 2)-1987	Requirement for particular group of relays, Section 2 Dependent specified time measuring relays
(Part 3/Sec 3)-1987	Requirements for particular group of relays, Section 3 Biased (percentage) differential relays

0.3 According to the classification on hierarchical basis [*see* IS : 3231 (Part 0)-1986*], this standard is a second level document.

0.4 In preparing this standard, assistance has been drawn from the following:

IEC Pub 255 (various parts) Electrical relays. International Electrotechnical Commission.

BS 142 : Section 2.2 : 1982 Electrical protection relays: Part 2 Requirements for the principal families of protection relays: Section 2.2 Specification for general requirements for measuring relays used for protection. British Standards Institution.

0.5 Information and explanatory comments on specifying measuring relays for protection are given in Appendix A.

1. SCOPE

1.1 This standard (Part 2/Sec 2) specifies the general performance requirements for electrical protection measuring relays excluding thermal electrical relays.

1.2 This standard applies only to relays in new condition.

1.3 This standard excludes relays in the following electrotechnical fields:

a) Telephony,
b) Telegraphy, and
c) Signalling and blocking in railway systems.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 1885 (Part 9)-1986† shall apply.

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*Specification for electrical relays for power system protection: Part 0 General introduction and list of parts (*first revision*).

†Electrotechnical vocabulary: Part 9 Electrical relays (*first revision*).

3. STANDARD VALUES

3.1 Input Energizing Quantities — No rated values of input energizing quantities are specified. The series given in **3.1.1** and **3.1.2** are preferred values, of which the underlined values have found greater acceptance. There are no preferred values for primary relays.

3.1.1 *Secondary Relays*

a) *AC voltages* (*rms*) — The preferred rated values of voltages for ac are given below:

110, 240 V and these values multiplied by $\sqrt{3}$ or $\frac{1}{\sqrt{3}}$

b) *AC currents* (*rms*) — The preferred rated values of current for ac are given below:

0·5, $\underline{1}$, 2 and $\underline{5}$ A.

3.1.2 *Shunt Relays* — The preferred rated values of voltages are given below:

30, 45, 50, 60, 75, 100, 150, 200, 300, and 600 mV.

3.2 Auxiliary Energizing Quantities — No rated values of auxiliary energizing quantities are specified. The series given below are of preferred values, of which the underlined values have found greater acceptance.

3.2.1 *AC Voltages* (*rms*) — The preferred values are given below:

24, 48, 50, 55, $\frac{100}{\sqrt{3}}$, $\frac{110}{\sqrt{3}}$, $\frac{120}{\sqrt{3}}$, 100, $\underline{110}$, 115, 127,

200, 220, $\frac{415}{\sqrt{3}}$, 380, $\underline{415}$, 480, 500 and 660 V.

3.2.2 *AC Currents* — There are no preferred values.

3.2.3 *DC Voltages* — 6, 12, $\underline{24}$, 30, $\underline{48}$, 60, $\underline{110}$, $\underline{125}$, $\underline{220}$, 250 and 440 V.

3.2.4 *DC Currents* — There are no preferred values.

3.3 Frequency — The standard rated values of frequency shall be selected from the following, the underlined value being preferred.

60, 50 and 16$\frac{2}{3}$ Hz.

3.4 Operating Times

3.4.1 *Independent Specified Times* — There are no standard values for independent specified times. However, for relays having a time-setting range, the maximum values given in Appendix B are preferred.

3.4.2 *Dependent Specified Times* — Values of dependent specified time shall be in accordance with lower level documents.

3.5 Characteristic Quantities — Values of characteristic quantities shall be in accordance with lower level document.

3.6 Standard Reference Values of Influencing Quantities and Factors and Standard Values of Their Nominal and Extreme Ranges

3.6.1 *Standard Reference Value of Influencing Quantities and Factors* — The standard reference values of influencing quantities and factors, and the associated test tolerances are specified in Table 1.

3.6.1.1 Where special conditions of application or the character of the relay necessitate the use of non-standard values, the manufacturer shall state the reference values and tolerances (for example, special applications may necessitate the use of 44°C as the reference value of ambient temperature instead of 27°C).

3.6.1.2 *Self-heating* — The manufacturer shall declare the effects of self-heating of relays mounted as in normal service where these are significant, that is, if they cause changes in accuracy which are of the same order of magnitude or greater than the assigned error.

3.6.1.3 In the absence of any specific requirement being given in lower level documents, the following requirements shall apply:

a) Each of the voltages (between any two lines and between line and neutral) of a poly-phase symmetrical system shall not differ by more than 1 percent from the average of such voltages;

b) Phase currents shall not differ by more than 1 percent from the average of system currents; and

c) The angles between each current and its phase to neutral voltage shall be the same, subject to a tolerance of two electrical degrees.

TABLE 1 STANDARD REFERENCE CONDITIONS AND TEST TOLERANCES OF INFLUENCING QUANTITIES AND FACTORS

(*Clauses* 3.6.1 *and* C-3.1)

	INFLUENCING QUANTITY OR FACTOR (1)	REFERENCE CONDITION (2)	TEST TOLERANCES (3)
General	Ambient temperature	27°C	± 2°C
	Atmospheric pressure	86 to 106 kPa (860 to 1 060 mbar)	—
	Relative humidity	45 to 75 percent	*See* Note 1
	Position	As declared by the manufacturer	3 degrees in any direction, or for static relays, as declared by the manufacturer
	External magnetic induction	Equal to or less than 10 times earth's induction (*see* Note 2)	—
	Self-heating	*See* **3.6.1.2**	—
Characteristic and input energizing quantities	Magnitude of input energizing voltages (reference for determination of variations)	As specified in lower level documents (*see also* Note 3)	As declared by manufacturer
	Magnitude of input energizing currents (reference for determination of variations)	do	do
	Phase angle between input energizing quantities	As specified in lower level documents (*see also* Note 3)	± 2°C
	Frequency	Rated value	± 0·5 percent (*see* Note 4)
	Waveform	Sinusoidal	Distortion factor 2 percent (*see* Notes 5 and 6)
	Alternating component in dc (ripple) (*see* Note 7)	Zero	Not greater than 3 percent

(*Continued*)

TABLE 1 STANDARD REFERENCE CONDITIONS AND TEST TOLERANCES OF INFLUENCING QUANTITIES AND FACTORS — *Contd*

Influencing Quantity or Factor (1)			Reference Condition (2)	Test Tolerances (3)
Characteristic and input energizing quantities	DC component in ac	Steady state	Zero	Not greater than 2 percent of peak value
		transient	Zero	Not greater than 2 percent of peak value
	Setting value		To be declared by the manufacturer when it differs from the value nearest to the mean of the range	To be declared by the manufacturer
	Balanced polyphase supplies		*See* **3.6.1.3**	*See* **3.6.1.3**
Time	Parameters of characteristic curve		As specified in lower level documents	As specified in lower level documents
	Setting value		To be declared by the manufacturer when other than maximum	To be declared by the manufacturer
Auxiliary energizing quantities	Voltage of current		Rated value(s)	As declared by the manufacturer or specified in lower level documents
	Frequency		Rated value	± 0·5 percent (*see* Note 4)
	Waveform		Sinusoidal	Distortion factor 2 percent (*see* Notes 5 and 6)
	AC component in dc		Zero	Not greater than 3 percent (*see* Note 7)
	DC component in ac	steady state	Zero	Not greater than 2 percent of peak value
		transient	As specified in lower level documents	As specified in lower level documents

(*Continued*)

NOTE 1 — During tests for variations due to temperature, this range of humidity may be exceeded provided that no condensation occurs.

NOTE 2 — Conventionally taken as 0·5 mT.

NOTE 3 — For determination of errors, the effective range is equivalent to a reference range. For determination of variations due to other influencing factors, the manufacturer may declare a single value within the effective range as the reference value.

NOTE 4 — If the performance of the relay is independent of the frequency, the tolerance may be larger. When the relay is highly frequency-dependent and greater accuracy is required, smaller tolerances may be necessary.

NOTE 5 — If the performance is highly dependent on the waveform, smaller tolerances may be necessary.

NOTE 6 — Distortion factor is the ratio between the rms value of the harmonic content obtained by subtracting the fundamental wave from a nonsinusoidal periodic quantity and the rms value of the non-sinusoidal quantity. It is usually expressed as a percentage.

NOTE 7 — Alternating component in dc (that, is the ripple content of a dc supply expressed as a percentage) is given by the following equation:

$$\text{Ripple content} = \frac{\text{maximum instantaneous voltage} - \text{minimum instantaneous voltage}}{2 \times \text{dc component}} \times 100 \text{ percent}$$

where

dc component is the mean value of the waveform.

3.6.2 *Standard Values of Limits of Nominal Ranges of Influencing Quantities and Factors* — The standard values of the limits of nominal ranges of influencing quantities and factors are specified in Table 2. Additional requirements apply in respect of the following:

a) *Relative humidity* — There shall be neither condensation nor ice formation inside the relay.

b) *Calibration conditions* — The manufacturer shall declare the conditions under which the calibration has been made and the effects, due to the transient dc component in the ac if these are significant that is, of the same order of magnitude or greater than the assigned error. In this case, the manufacturer shall declare the errors for the following three values of time constant:

   0, 40 and 100 ms

   The reference conditions, both for transient and steady state, shall be in accordance with **3.6.1**.

   Where special conditions of application necessitate the use of non-standard values, the manufacturer shall declare the values used.

TABLE 2 STANDARD VALUES OF LIMITS OF THE NOMINAL RANGES OF INFLUENCING QUANTITIES AND FACTORS

(*Clauses* 3.6.2, A-1 *and* C-3.1)

	Influencing Quantity or Factor (1)	Nominal Range (2)
General	Ambient temperature	From −5 to 45°C (*see also* Note 1)
	Atmospheric pressure	80 to 110 kPa (800 to 1 100 mbar)
	Relative humidity	95 percent maximum at 35°C [*see also* Note 2 and **3.6.2**(a)]
	Position	5° in any direction from reference position or for static relays, as declared by the manufacturer
	External magnetic induction	Not specified
	Self-heating	*See* **3.6.1.2**
Characteristic and input energizing quantities	Magnitude of input energizing voltage(s)	As specified in lower level documents
	Magnitude of input energizing current(s)	
	Phase angle between energizing quantities	
	Frequency	47 to 51 Hz
	Waveform	As specified in lower level documents
	DC component in ac — Steady state — Transient	
	Setting	All available settings other than reference value
Time	Setting	do
Auxiliary energizing quantities	Voltage	The values shall be declared by the manufacturer when these differ from 80 and 110 percent of the rated value
	Current waveform	As specified in lower level documents or declared by the manufacturer
	AC component in dc	0 to 6 percent of the rated dc value

NOTE 1 — When one or more relays, which are mounted in their cases, are mounted in an additional case or a small closed space, precautions should be taken to ensure that the temperature of the air immediately surrounding the relay does not exceed the upper limit of the nominal range.

NOTE 2 — Test procedure for this is under consideration.

3.6.2.1 *Limits of nominal ranges of temperature* — The standard limits for nominal ranges of temperature shall be selected from the following values:

$\underline{-5 \text{ to } +45^\circ\text{C},}$ -10 to $+55^\circ$C, -25 to $+40^\circ$C, and -25 to $+55^\circ$C.

The underlined range is preferred.

3.6.2.2 If the input energizing quantity is not identical to the characteristic quantity (for example, frequency relays), the input energizing quantity shall be regarded as an influencing quantity and the manufacturer shall declare the limits of the nominal range.

3.6.2.3 Maximum measuring relays shall operate at all values of the input energizing quantity between the rated value and the thermal withstand value.

The operative range of minimum measuring relays shall be declared by the manufacturer.

The above requirements shall be met when the auxiliary energizing quantity has any value within its nominal range.

3.6.3 *Standard Values of Limits of Extreme Ranges of Influencing Quantities and Factors*

3.6.3.1 *Limits of extreme range of temperature* — The standard values of limits of the extreme range of temperature are:

-25 and $+70^\circ$C.

The limits of extreme range of temperature take into account installation, storage and transport conditions. They are applicable only to unenergized relays.

NOTE — Temperature is an example of those influencing quantities which may cause irreversible changes in relays.

3.6.3.2 *Limits of extreme ranges of other influencing quantities or factors* — Not specified.

3.7 Standard Values of Limits of Setting Range of the Characteristic Quantity — Values for limits of setting range of the characteristic quantity may be given in lower level document.

3.8 Standard Values of Resetting and Disengaging Ratio (or Percentages) — Values of resetting and disengaging ratios (or percentages) may be given in lower level documents.

4. VALUES OF LIMITS OF OPERATIVE RANGES OF AUXILIARY ENERGIZING QUANTITIES

4.1 General — The limits of operative range for each auxiliary energizing quantity shall be declared by the manufacturer.

4.2 Preferred Range — The preferred limits of operative range for each auxiliary energizing quantity are 80 to 110 percent of the rated value.

4.3 Other Cases

4.3.1 *Relays Having a dc Auxiliary Energizing Quantity and Associated with a Tripping Function in Protection Systems* — The limits of operative range for dc auxiliary energizing quantities shall be 70 and 110 percent of the rated value.

NOTE — For lead acid Plante' batteries having a nominal voltage of 2 V per cell the normal working voltage, based on 2·27 V per cell, would give minimum and maximum operating voltages of 1·85 and 2·5 V per cell respectively.

Example — A 55 cell battery having a nominal voltage of 110 V would normally be associated with relays having a rated voltage of 125 V and limits of operative range of 87·5 and 137·5 V.

4.3.2 *General* — When the limits of an operative range otherwise differ from the preferred values given in **3.1**, the manufacturer shall declare the limits of range and the corresponding rated value.

5. THERMAL REQUIREMENTS

5.1 Maximum Permissible Temperatures — The maximum temperatures of insulating materials associated with energizing circuits shall not exceed those permitted for the appropriate insulation class in IS : 1271-1985*. The requirements concerning maximum temperature apply at all settings.

New insulating materials, not yet included in IS : 1271-1985*, may be used at other maximum temperatures if the same degree of safety is ensured.

The maximum temperatures of other components or materials within the relay shall not exceed the thermal ratings assigned to them by the relevant component standards.

The ambient temperature for the purpose of temperature-rise test shall not exceed 45°C.

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*Thermal evaluation and classification of electrical insulation (*first revision*).

5.2 Continuous and Limiting Temporary Withstand Values of Input Energizing Quantities

a) *Relays for Continuous Duty*

1) *Voltage relays* — Voltage relays shall withstand the continuous application of a voltage 10 percent of the maximum voltage setting or 10 percent in excess of the rated voltage, whichever is higher.

2) *Other relays* — For relays other than voltage relays, the manufacturer shall declare for all input energizing circuits of the relay, the highest permissible continuous values of the energizing quantities. The value for one input energizing quantity shall be given with the other input energizing quantities at their rated values unless otherwise declared by the manufacturer.

b) *Relays for Short Time (Temporary) Duty* — The manufacturer shall declare, as appropriate for all input energizing quantities of the relay, the limiting temporary withstand values of the input energizing quantities. The value for one input energizing quantity shall be given with the other input energizing quantities at their rated values unless otherwise declared by the manufacturer. The duration of energization shall also be declared by the manufacturer.

5.3 Limiting Short-Time Thermal Withstand Value — The requirements relating to limiting short-time thermal tests apply only to input energizing quantities.

a) *Relays for Continuous Duty* — The manufacturer shall declare the limiting short-time thermal withstand value for each input energizing quantity of the relay. The relay shall withstand for each input circuit a single application of the limiting short-time thermal withstand value of the corresponding input energizing quantity. The manufacturer shall also declare the corresponding withstand times, the preferred values of which are 1 s for current circuits and 10 s for voltage circuits.

NOTE — Attention is drawn to the possible special needs of specified time relays or relays associated with timing devices.

The manufacturer shall declare the values of other input energizing quantities, the rated values being the preferred values.

b) *Relays for Temporary Duty*

1) *Voltage relays* — Voltage relays shall withstand for all input circuits, a single application of a voltage as declared by the

manufacturer in excess of the voltage setting for a time equal to the operating time of the relay at that voltage. The minimum time of application shall be 0·5 s.

2) *Other relays* — Relays other than voltage relays shall withstand for all input circuits, a single application of the limiting short-time thermal withstand value of the corresponding input energizing quantities. The other input energizing quantities shall be at their rated values unless otherwise declared by the manufacturer. The limiting short time thermal withstand value as well as the duration shall be declared by the manufacturer.

NOTE — Attention is drawn to the special requirements for relays affected by automatic reclosing equipment, Petersen coil earthed systems, etc (*see* lower level documents).

5.4 Limiting Dynamic Value — The limiting dynamic value 'peak' shall be at least 2·5 times the limiting short time thermal withstand value (rms) and the manufacturer shall declare the conditions under which this value applies for relays with more than one input energizing quantity, the value of all the energizing quantities, phase angle, etc.

This limiting dynamic value applies to the current input circuits only.

6. ACCURACY

6.1 General — For measuring relays, considerations of accuracy apply to the characteristic quantity and to the specified time(s), if any. The accuracy applicable to the characteristic quantity and to the time(s) may be different. Relays shall be in a new condition. All tests other than these for variations shall be made under reference conditions. Accuracy requirements for particular types of relays shall be as specified in the appropriate lower level document. Any preconditioning of the relay (for example, whether the steady self-heating error had been reached before commencement of the test) shall be declared by the manufacturer.

6.2 Declared Performance — The manufacturer shall declare the assigned error variations due to influencing quantities or factors and where relevant, the effective ranges of characteristic or input energizing quantities, and the consistency.

a) *Reference Conditions* — An assigned error shall be declared for all types of relay under reference conditions. The errors for all relays of given type shall be less than or equal to the declared value of assigned error under these conditions. When the assigned error, expressed as a percentage, falls between 0·5 and 20, it shall preferably be expressed as a number chosen from the following series.

0·5, 1·0, 1·5, 2·5, 5·0, 7·5, 10 and 20.

NOTE — **Manufacturer may quote other values (*see* Appendix C).**

b) *Nominal Range of Influencing Quantities and Factors* — When the variation in error due to changing in any one influencing quantity or factor between the limits of its nominal range is declared, the corresponding tests shall be made under reference conditions with the exception of the single influencing quantity or factor for which the variation is being determined.

For determination of variations, the mean error shall be the mean of ten measurements unless otherwise declared by the manufacturer.

c) *Effective Range* — When the manufacturer declares an effective range of characteristic quantity or input energizing quantity(ies) over which considerations of accuracy apply, account shall be taken of the variations permissible as a result of departures from the reference conditions. The relevant accuracy over this range is as specified in lower level documents.

6.3 Methods of Determining Errors — The methods of determining errors shall be as specified in lower level documents.

6.4 Presentation of Relay Characteristics — Recommended methods of presenting relay characteristics will be given, where appropriate, in lower level documents.

7. OVERSHOOT TIME

7.1 For relays having a specified time delayed operation, the manufacturer shall declare the maximum overshoot time when the input energizing quantity is suddenly changed from one specified value to a second specified value which would normally not cause operation. All other influencing quantities or factors shall be at their reference values. Test conditions shall be as specified in lower level documents.

8. RATED BURDEN AND RATED IMPEDANCE

8.1 The value of the rated burden shall be declared by the manufacturer for each energizing circuit under the following conditions:

a) The relay being cold (that is, without previous self-heating);

b) The influencing quantities and factors being under their reference conditions; and

c) The circuit under consideration being energized at its rated value or in a manner declared by the manufacturer, all other circuits being unenergized unless otherwise stated by the manufacturer or as specified in lower level document.

If the burden is affected by the position of the moving parts, the values corresponding to the operated and initial positions shall be declared together with the minimum and maximum values if they do not correspond to these two positions.

In addition, the manufacturer shall declare sufficient information regarding the burden of the input energizing circuits to enable the appropriate voltage and current transformer burden requirements to be defined.

The burden shall be expressed:

a) in watts for dc circuits, and

b) in volt amperes for ac circuits, together with the value of the power factor.

NOTE 1 — The concepts of burden and impedance are analogous and for simplicity this clause has been written in terms of burden.

NOTE 2 — In addition to the requirements given above, the value of the burden may also be declared at the other setting values of the characteristic quantity.

9. MECHANICAL REQUIREMENTS

9.1 Mechanical Durability — Unless otherwise agreed to by the manufacturer and the user, the relay shall be capable of performing 10 000 operations with no load in the output circuit and when tested under the conditions specified in this standard. The tests of mechanical durability are not required for static relays without contacts.

9.2 Shock and Vibration

9.2.1 *Classification* — Relays shall be classified with respect to their ability to withstand the mechanical shocks and vibration likely to be experienced in a particular location or type of use, in accordance with Table 3.

9.2.2 *Mechanical Shock Requirements* — Under consideration.

9.3 Vibration Requirements

9.3.1 Relays falling into classification S2 shall be subjected to a resonance search vibration test as specified in **14.2**. During the test, no unduly severe resonance or relay malfunction shall occur within the nominal frequency range of the input energizing quantity(ies) or in the ranges which are sub-multiples or multiples of this range.

Where the size of the relay renders it impracticable to test it as a whole, it may be tested as functional sub-units, as agreed between the manufacturer and the purchaser.

TABLE 3 RESISTANCE TO MECHANICAL SHOCK AND VIBRATION

(*Clause* 9.2.1)

MECHANICAL STABILITY CLASS INDEX (1)	NORMAL USE (2)	TYPICAL EXAMPLE OF APPLICATION (3)
S1	Sensitive relays which may require external protection from mechanical shock and/or vibration	Sensitive measuring relays requiring external anti-vibration mounting
S2	Relays suitable for normal industrial conditions of shock and vibration	Stationary locations free from shock and vibration in excess of those described in **9.3** and heavily damped swing panels
S3	Relays intended for more onerous conditions than S1 and S2	Shipboards, traction and undamped swing panels

NOTE — S3 conditions would normally be agreed between the manufacturer and the purchaser in the light of specific application requirements.

9.3.2 If a malfunction occurs at any other frequency within the 10 to 300 Hz range, acceleration shall be decreased to zero and then increased to 0·15 g_n at the frequency(ies) at which the malfunction occurred. No malfunction shall occur at 0·15 g_n.

9.3.3 The 0·15 g_n acceleration level is subject to a maximum peak amplitude of 0·039 mm over the frequency range 30·9 to 300 Hz. Below 30·9 Hz, the maximum permissible acceleration level is as shown in Fig. 1.

9.3.4 Relay malfunction shall be detected as specified in **14.2**. Relays failing to comply with these requirements are deemed to fall within class S1. The requirements for vibration testing of Class S3 relays shall be the subject of special agreement between the manufacturer and the purchaser because they are dependent upon specific operational environments.

NOTE — Class S1 relays may be used in Class S2 situations either by virtue of special mounting techniques or by the use of special circuitory, for example, by the use of time-lags.

9.3.5 Prior to the test, the accuracy of the relays shall be checked under reference conditions (*see* **6** and Appendix C). At the conclusion of the tests, the accuracy shall be re-checked and the variation in error from initial accuracy shall be noted which shall not be in excess of half the error assigned by the manufacturer.

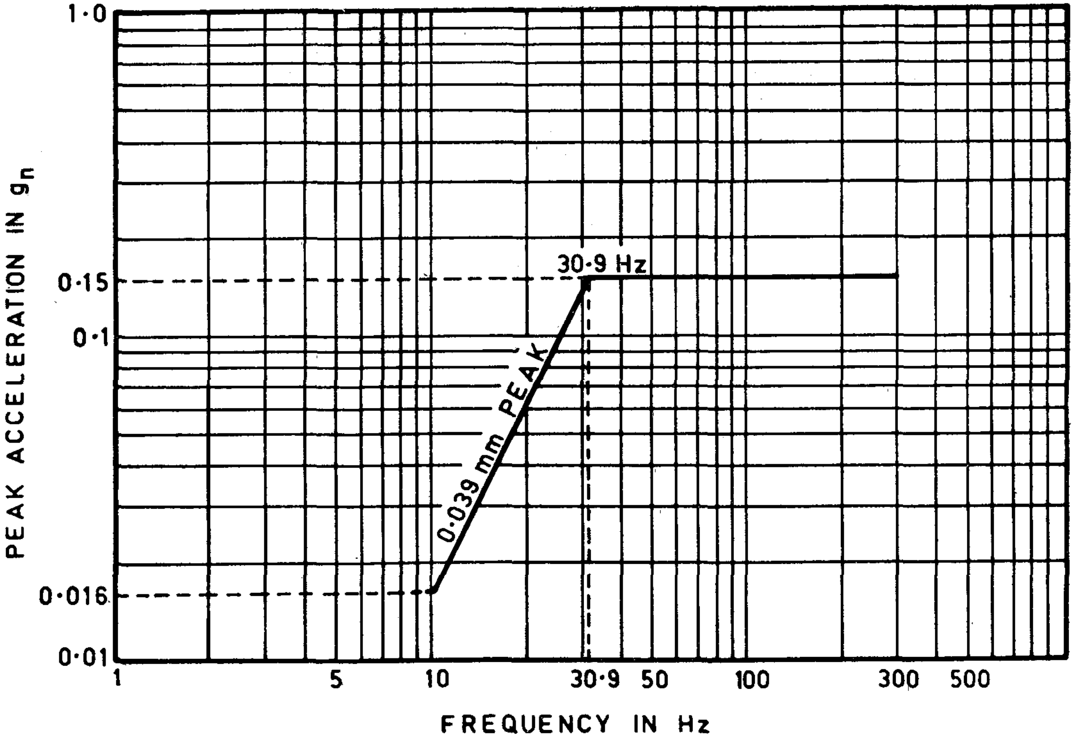

FIG. 1 MAXIMUM TEST ACCELERATION LEVELS FOR RESONANCES HARMONICALLY RELATED TO NOMINAL FREQUENCY RANGE

9.4 Contact Performance — For relays with output contact, the contact shall meet the requirements of IS : 3231 (Part 1/Sec 1)-1986*.

10. CONSTRUCTIONAL REQUIREMENTS

10.1 General

10.1.1 The general construction shall be such that the relay element and any draw-out or plug-in contacts are not liable to distortion or damage as a result of change of temperature, presence of moisture or other normal service conditions or whilst conforming to the mechanical durability and thermal requirements.

In case, relays are required for chemical or hazardous gases atmosphere, additional precautions in construction shall be taken as agreed between the manufacturer and the user.

10.1.2 Relays of modular construction, designed for insertion into a standard housing, shall be provided with protection against possible electrical or mechanical damage when the modules are being withdrawn or replaced.

10.1.3 The relay shall be so designed that mechanical resonance which causes damage does not occur within the nominal frequency range of the input energizing quantity nor submultiple thereof.

10.1.4 The relay shall be so designed that over the nominal temperature range, no part or component shall reach a temperature in excess of that given in the relevant component and/or material specification or suffer irreversible damage as a result of thermal testing.

10.1.5 Components or elements that can be adversely affected by the presence of dust shall be fitted with an enclosure capable of meeting classification IP 50 in accordance with IS : 2147-1962†.

10.2 Enclosing Case — The relay shall be arranged so that it is possible to observe any visual indicators when they have operated and also, where practicable, the relay setting(s) without removing the cover. Facilities shall be provided to earth all exposed metal parts of metal-cased relays unless the relay is marked to the contrary.

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*Specification for electrical relays for power system protection: Part 1 General requirements, Section 1 Contact performance (*first revision*).

†Degrees of protection provided by enclosures for low voltage switchgear and controlgear.

10.3 Draw-Out and Plug-In Units — The general construction shall be such that any person inserting or withdrawing the unit with reasonable care shall not come into contact with live parts. These items shall be capable of following number of operations without suffering any damage (one operation consists of one insertion and one withdrawal):

a) Plugs and sockets of withdrawable relays and components regularly withdrawn for routine maintenance or service : 500 operations.

NOTE — When frequent checking of equipment is usual, the number of operations should be related to testing frequency and expected life.

b) Edge connectors of printed cards, plugs and sockets of replaceable items which are infrequently withdrawn: 100 operations.

When the results of tests made in accordance with **14.2** indicate the need, provision shall be made for locking the withdrawable element in position.

Unless otherwise indicated, the manufacturing tolerances shall be such that any chassis or plug-in relay of the same design and type, can be inserted in any case or base of corresponding design made by the same manufacturer and the relay shall still meet the requirements of this standard.

On withdrawable modules, the withdrawable position shall be identifiable with the relevant fixed position.

Plug-in units which are not directly interchangeable in terms of electrical performance or cases which have restrictions on the plug-in units they will accept, shall be marked to show that reference shall be made to a separate document by using the symbol ⚠ .

NOTE — Care should be taken by the user to replace the correct type of element after having withdrawn elements from cases.

Draw-out cases shall be arranged so that with reasonable care, it is not possible to cause inadvertent tripping signals either during the process of withdrawing the plug-in unit or of re-inserting it. Where the breaking of normally made circuits can cause consequential malfunction or damage to equipment (for example, open-circuiting of current transformers), the withdrawable contact arrangements shall be such that the appropriate terminals of relay are short-circuited before the corresponding circuits are opened. In a multiple element relay, the manufacturer shall ensure that withdrawal or insertion of any one or more elements does not cause damage to the remaining elements nor cause tripping. A mechanical arrangement to the draw-out element (cards) is preferable to avoid inadvertent insertion in its position. An identification mark may be provided on the withdrawable element (card) for its proper position and insertion.

10.4 Settings and Other Adjustments

10.4.1 All setting adjustments shall be inaccessible until the case or cover, or some portion thereof, has been removed.

10.4.2 If the relay is intended for setting adjustment on load (the adjustment being directly in a current transformer secondary circuit), means shall be provided to ensure that the current transformer is not open-circuited during adjustment, and the manufacturer shall specify the value of the setting which is effective during the adjustment.

10.4.3 Where variable settings are provided, the selected setting(s) shall be clearly identifiable. The positions of the adjustment controls shall not change under service conditions nor, when reasonable care is used, shall it be possible to alter the adjustments accidentally.

10.5 Operation Indicators and Signal Relays

10.5.1 Operation indicators and signal relays shall show that the appropriate elements have operated. The operated state shall be clearly distinguishable from the unoperated state by a mechanical flag or LED.

To show the operated position of the element, a mechanical indicator, when provided, shall have contrasting colours, preferably red on a white background. The operation of a mechanically inter-locked indicator shall, as far as possible, be synchronized with the operation of relay contacts, but in the absence of such synchronism, the indicator shall operate in advance of the contacts.

10.6 External Terminals

10.6.1 The same dielectric test voltage shall apply to all exposed terminals of any one relay and shall be the highest test voltage (but not exceeding 2 kV) associated with the particular relaying equipment. The limit of 2 kV does not apply to relays connected to pilot cables [*see* **5.2.2** of IS : 3231 (Part 1/Sec 2) - 1986*].

Exposed relay terminals insulated for voltages above 5·5 kV shall be fitted with insulating shrouds or barriers.

11. MARKING AND DATA

11.1 Data

11.1.1 The following data (with indication of the units, where applicable) shall be made available by the manufacturer:

a) Manufacturer's name or trade mark;

b) Type designation;

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*Specification for electrical relays for power system protection: Part 1 General requirements, Section 2 Insulation tests (*first revision*).

c) If available, model or serial number;

d) Rated values of input and auxiliary energizing quantities;

e) Values of limits of operative ranges of auxiliary energizing quantities;

f) Frequency for ac or the symbol ⎓ for dc;

g) Contact data;

h) Rated value or setting range of characteristic quantities and/or angle;

j) Limiting short-time thermal withstand value;

k) Identification and location of removable parts;

m) Burden data;

n) Dielectric test voltage(s);

p) Mechanical position;

q) Mounting position;

r) Data to permit suitable connection of relay (including polarity);

s) Details of accessories (if essential to the relay performance);

t) Data concerning earthing of certain metal parts;

u) Precautions to be taken by the user when replacing parts of modules marked with the symbol ⚠ ; and

v) Impulse test voltage data.

11.2 Marking

11.2.1 The following data shall be marked on the relay distinctly and permanently in a position visible from the front:

a) Manufacturer's name or trade mark; and

b) Manufacturer's type designation.

11.2.2 The following data shall be marked on or in the relay without necessarily being visible from the front:

a) Model or serial number;

b) Rated values of input and auxiliary energizing quantities;

c) Frequency for ac or symbol for dc;

d) Rated value or setting range of characteristic quantity or angle or both;

e) Particulars of auxiliary equipment; and

f) Country of manufacture.

The symbol ⚠ may be used to indicate parts or modules which should not be replaced without observing precautions prescribed by the manufacturers.

12. TESTS

12.1 All tests in this standard are type tests, out of which the following shall constitute routine tests:

a) Measurement of assigned errors(s) under reference conditions (**6**),

b) Values of resetting and disengaging ratios (or percentages) (**3.8**), and

c) Dielectric tests [**5** of IS : 3231 (Part 1/Sec 2)-1986*].

13. TESTS FOR THERMAL REQUIREMENTS

13.1 During tests for thermal requirements, the following general conditions shall be fulfilled:

a) When testing at continuous thermal withstand value, the declared value shall be applied for a time sufficient to enable a steady temperature to be attained;

b) The relay shall be mounted as in normal service;

c) The ambient temperature shall be declared by the manufacturer and shall not exceed 45°C.

NOTE 1 — It follows from the above requirements that temperature rise may not necessarily be the same for different ambient temperatures.

NOTE 2 — Attention is called to Note 1 under Table 2 for those cases where relays are mounted in an additional enclosure and may require a higher ambient temperature rating.

d) When an assessment of maximum temperatures is made, the state of the output circuits shall be declared;

e) The auxiliary energizing quantities shall be at the upper limits of their operative ranges. During the test, the requirements as given in **5.1** shall be complied with;

f) After the test, when restored to reference conditions, the relays shall meet all other requirements of this specification;

g) If the input energizing circuits other than that under test are not energized at their rated values; the manufacturer shall declare the values used; and

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*Specification for electrical relays for power system protection : Part 1 General requirements, Section 2 Insulation tests.

h) All other influencing quantities and factors shall be at reference conditions. Tests shall be accomplished with all corrections made to the relay in normal manner.

13.2 Tests to Prove Highest Permissible Continuous and Limiting Temporary Withstand Values of Input Energizing Quantities

13.2.1 *Continuous Withstand* — A continuous thermal withstand value shall be applied to the appropriate input energizing circuit for sufficient time to ensure that the temperature of each component of the relay is stable.

13.2.2 *Limiting Temporary Withstand* — The limiting temporary withstand value shall be applied to the appropriate input energizing circuit for the time duration declared by the manufacturer.

13.3 Tests for Limiting Short-Time Thermal Ratings — Overload tests to prove limiting short-time thermal rating shall be conducted by applying the limiting short-time thermal values to input energizing circuit only and for the time specified in **5.3.**

13.4 Tests for Limiting Dynamic Value — The limiting dynamic value of the corresponding input energizing quantities shall be applied to the appropriate input terminals (*see* **5.4**). The limiting dynamic value of current shall be produced with either an off-set sinusoidal waveform or a symmetrical sinusoidal waveform of rated frequency. The duration of the test shall at least be one half-cycle. . The relay shall withstand at each appropriate set of its input terminals, a single application of the limiting dynamic value at the most severe polarity.

After the test, the relay shall have suffered no permanent degradation of its characteristics.

14. TESTS FOR MECHANICAL REQUIREMENTS

14.1 Mechanical Durability

14.1.1 *Test Conditions* — The relay shall be tested under the following conditions, which shall be fulfilled simultaneously:

a) Mounted as for normal service;

b) At rated values of auxiliary energizing quantities;

c) Under reference conditions of all influencing quantities and factors other than the setting [*see* **14.1.1**(e)];

d) At rates (cycles per min) specified by the manufacturer; and

e) For relays with adjustable settings, at the relay's lowest setting.

14.1.2 *Test Procedure* — To facilitate testing of mechanical durability, a small load, defined by the manufacturer in terms of current and voltage, may be applied to the output circuits (for example, for operation counters).

Throughout the tests of mechanical durability, the relay shall comply with return and/or disengage requirements. Any routine maintenance or replacement recommended by the manufacturer is permissible during the tests, but no other parts may be replaced.

For static relays with contacts, an exception may be made for relays of generally similar design having electromechanical output relays of identical design and with an identical method of mounting of the output relay. In this case, after one relay has been proved to meet the mechanical durability requirements, it shall not be necessary to repeat the mechanical durability tests for similar relays.

The tests on mechanical durability are not required for static relays without contacts.

14.1.3 *Test Conclusion* — At the conclusion of the test:

a) The relay shall be in good mechanical condition and shall be capable of fulfilling its designed functions at least once at the maximum and once at the minimum values of the operative ranges of the auxiliary energizing quantities;

During these latter tests, the output circuit(s) shall carry the maximum current rating(s) assigned to them by the manufacturer. The details of these tests shall be declared by the manufacturer and the number of tests shall normally be limited to a maximum of four.

b) The errors shall not be more than twice the assigned errors declared by the manufacturer; and

c) The relay shall withstand a dielectric test with the voltage equal to 0·75 times, the value originally specified or claimed by the manufacturer.

14.2 Vibration Tests (for Class S2 Relays Only)

14.2.1 *Equipment*

14.2.1.1 *Mounting of relays* — The relay shall be fastened to the vibration generator table by its normal means of attachment. Care should be taken with the positioning of any additional straps or stays. Any connection to the equipment shall be arranged so that they impose no more restraint or mass than they would when the relay is installed in its operational position. The relay shall be mounted such that the gravitational force acts on it in the same relative direction as it would in normal use. Vibration amplitude and acceleration shall be measured at, or as near as possible to, one of the normal fixing points on the relay under test. Care should be taken to ensure that the relay under test is not significantly affected by magnetic fields generated by the vibration systems, if these are greater than the maximum permitted reference level of 0·5 mT.

14.2.1.2 *Vibration system* — The characteristics of the vibration generator and fixture when loaded for the tests shall be such as to produce a basic motion of sinusoidal form, so that the fixing points of the relay under test move substantially in phase and in straight parallel lines.

14.2.1.3 *Vibration level tolerance* — The actual vibration level in the required direction shall correspond to the requirements of **9.3.2**, **9.3.3** and **14.2.2.3**; and at each fixing point, where measurement is specified, the tolerances shall be those given in Table 4.

TABLE 4 VIBRATION LEVEL TOLERANCE

FREQUENCY (1)	IN THE FREQUENCY RANGE WHERE DISPLACEMENT AMPLITUDE IS SPECIFIED (*see* Fig. 1) (2)	IN THE FREQUENCY WHERE ACCELERATION AMPLITUDE IS SPECIFIED (3)
Not exceeding 150 Hz	± 25 percent	± 15 percent
Exceeding 150 Hz	—	± 25 percent

NOTE — Where it is difficult to achieve the figures quoted at some discrete frequencies within the frequency range, for example, for large specimens and/or at high frequencies, it is possible that a wider tolerance or an alternative method of assessment will be necessary.

14.2.1.4 *Frequency tolerances* — Measurement of frequency for determination shall be made with a tolerance of ± 0·5 Hz or ± 1 percent, whichever is greater. Other frequency tolerances shall be ± 1 Hz up to 50 Hz and ± 2 percent above 50 Hz.

14.2.2 *Procedure*

14.2.2.1 The test shall be carried out with the relay under reference condition.

14.2.2.2 The tests shall be carried out with the following values of energizing quantities (auxiliary and input) applied to the appropriate circuits:

Auxiliary energizing quantity(ies) — Rated value(s)
Input energizing quantity(ies) — As specified in Table 5.

For static relays or sub-units of relays which contain no moving parts, the relay or sub-unit may be tested unenergized, as agreed to between the manufacturer and the purchaser.

14.2.2.3 The relay under test shall be vibrated along each of its three major axes over the frequency range 10 to 300 Hz with accelerations as follows:

a) within the nominal frequency range of input energizing quantities, or in ranges that are multiples or submultiples of this range, an acceleration not exceeding 0·5 g_n; and

b) at any other frequency within the range 10 to 300 Hz, an acceleration not exceeding 0·15 g_n.

The actual vibration amplitude corresponding to this acceleration is determined from the following formula:

$$a_{pk} = 4\pi^2 f^2 x_{pk}$$

where

a_{pk} = peak value of acceleration;
x_{pk} = amplitude of vibration; and
f = frequency of vibration.

Malfunction of the output circuit(s) (contact or otherwise) shall be checked using a follower relay or device.

The function of the follower device is to indicate if the relay under test has malfunctioned by picking up (*p. u.*) or dropping off (*d. r.*). The preferred follower response times are:

a) 10 ms, and

b) 0·3 ms.

If a 10 ms relay is used, as a follower, any movement of its contacts should be taken to indicate malfunction. Flags or other operational indicators shall not change their initial state during the vibration test. Table 5 shows the conditions of the follower device both during the test and for indication of output circuit operation.

TABLE 5 VIRATION TEST CONDITIONS

(*Clauses* 14.2.2.2 *and* 14.2.2.3)

TYPE OF RELAY	TYPE OF OUTPUT CIRCUITS	TEST CONDITION: INPUT ENERGIZING QUANTITY (IES)	CONTACT POSITION	FUNCTION OF FOLLOWER DEVICES FOR INDICATION OF OUTPUT CIRCUIT OPERATION	CONDITIONS OF FOLLOWER DEVICE DURING TEST FOR CORRECT OPERATION
(1)	(2)	(3)	(4)	(5)	(6)
Maximum measuring	Make	Unenergized	Open	*p. u.*	De-energized
Maximum measuring	Make	Energized at 120 percent of operating value	Closed	*d. o.*	Energized
Minimum measuring	Make	Unenergized	Open	*p. u.*	De-energized
Minimum measuring	Make	Energized at 80 percent of operating value	Closed	*d. o.*	Energized
Maximum measuring	Break	Unenergized	Closed	*d. o.*	Energized
Maximum measuring	Break	Energized at 120 percent of operating value	Open	*p. u.*	De-energized
Minimum measuring	Break	Unenergized	Closed	*d. o.*	Energized
Minimum measuring	Break	Energized at 80 percent of operating value	Open	*p. u.*	De-energized
Directional	Make	Rated V and I - characteristic angle	Open	*p. u.*	De-energized
Directional	Make	Rated V and I-operating angle — 10°	Closed	*d. o.*	Energized
Directional	Break	Rated V and I-characteristic angle	Closed	*p. u.*	Energized
Directional	Break	Rated V and I-operating angle —10°	Open	*d. o.*	De-energized

15. HIGH FREQUENCY DISTURBANCE TEST

15.1 High frequency disturbance testing applies to static relays only. When such a test is required, it shall be carried out in accordance with IS : 3231 (Part 1/Sec 3) - 1986*.

16. INSULATION TESTS

16.1 Unless otherwise stated, provisions of IS : 3231 (Part 1/Sec 2)-1986† shall be applicable.

APPENDIX A

(*Clause* 0.5)

EXPLANATORY COMMENTS

A-1. For measuring relays, consideration should be given not only to the pick up and the drop out (intrinsic characteristics) but also, and sepecially to the operating and/or resetting and the associated characteristics (to start, to switch, to disengage, to return). These characteristics (operating characteristics) are all concerned with the characteristic quantity of a measuring relay which, in certain instances, may be of the same nature as the input energizing quantity (current relay, voltage relay) but may be a derivative of two input energizing quantities (power relay, impedance relay). However, the application to a measuring relay of its characteristic quantity is always associated with conditions relating to the accuracy.

For measuring relays, auxiliary energizing quantities are always to be considered as influencing quantities. In effect, if their values are different from the rated values, the specified performance, particularly its accuracy, of a measuring relay may be changed. It follows that the concepts of operative range and also classes of use are not so important for the auxiliary energizing quantities of measuring relays as they are for all-or-nothing relays. It is only necessary to consider the rated value of each auxiliary energizing quantity and its nominal range (as for other influencing quantities) to determine the performance of a measuring relay with respect to its accuracy and variation. In order that the performance of relays may be assessed and compared, it is necessary that tests be made at prescribed values of the influencing quantities, these values being the reference values. When all the influencing quantities have their reference values, the relay is said to be under 'reference conditions'. Since, the effects on relay operation of small changes in influencing quantities are presumed to be negligible, and since there may be practical difficulties in maintaining precisely the reference values, small tolerances about each reference value are permitted in **3.6.1** to allow for possible measurement and control errors when reproducing the reference conditions of influencing quantities.

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*Specification for electrical relays for power system protection : Part 1 General requirements, Section 3 High frequency disturbance test for static relays.

†Specification for electrical relays for power system protection : Part 1 General requirements, Section 2 Insulation tests.

It is emphasized that, during testing, the different influencing quantities are varied one at a time within their nominal ranges: that is, a single influencing quantity will be varied throughout its range whilst all the other influencing quantities are maintained at their reference values (subject to the tolerances indicated in this standard).

It is virtually impossible, in a general standard of this nature, to predict the cumulative effect of simultaneous changes of a number of influencing quantities each within its own range.

The reference values, together with their associated tolerances, constitute the standard test conditions for relays. Nevertheless, for particular applications complementary specification requirements may be necessary; these should generally be in the spirit of this standard (for example, relays intended to be used continuously at very high ambient temperatures).

The specified performance of a relay is related to a given set of reference conditions. In practice, however, the relay must be capable of being used under conditions which are less restricted than the reference conditions. The ranges within which a relay is intended to be usable are called the 'nominal ranges of the influencing quantities or factors', and their limits are given in Table 2.

Finally, a relay may be subjected to even more extreme conditions during for example, installation, storage and/or transport. These are referred to as the limits of extreme ranges of influencing quantities or factors (*see* **3.6.3**) and within these specified limits (but beyond the limits of nominal range), the relay is merely required to be capable of withstanding the effects of change of influencing quantity or factor without suffering any degradation which would not revert to normal when the reference conditions are restored. The relay is not required to operate correctly under these extreme conditions, since it is not envisaged that such conditions should arise during service.

APPENDIX B

(*Clause* 3.4.1)

SPECIFIED INDEPENDENT TIME RELAYS

B-1. It has not been possible to standardize rated values of the specified time. For specified time relays having a setting range of the specified time, it is, however, recommended that a value in Table 6 be adopted, whenever possible, as the maximum setting value of the specified time.

TBLE 6 PREFERRED VALUES OF THE SPECIFIED TIME

Time (1)	Preferred Values (2)									
Milliseconds (ms)	1,	3,	6,	10,	15,	30,	60,	100,	300,	600
Seconds (s)	1,	3,	6,	10,	15,	30	—	—	—	—
Minutes (m)	1,	3,	6,	10,	15,	30	—	—	—	—
Hours (h)	1,	3,	6,	12	—	—	—	—	—	—
Days (d)	1,	—	2,	3	—	—	—	—	—	—

APPENDIX C

[*Clauses* 6.2 (a) *and* 9.3.5]

NOTE CONCERNING THE ACCURACY OF RELAYS

C-1. GENERAL

C-1.1 This appendix deals with the performance of individual relays, so as to facilitate the correct application of a relay and to compare apparently similar relays. It is necessary to consider the accuracy of a relay under standardized conditions (that is, the reference conditions specified in this standard) and to consider the effects of departures from these conditions. Although, in actual use, several of the influencing quantities or factors may change simultaneously, practical test methods require that assessment be made of the effect of changes in influencing quantities or factors when only one departs from the reference conditions. The range within which each may vary (singly) is the 'nominal range' and the effects are referred to as 'variations'.

The requirements for performance (regarding accuracy under the reference conditions and variations within the nominal range of each influencing quantity or factor) are given in **6** and this appendix describes some of the concepts.

C-2. ACCURACY UNDER REFERENCE CONDITIONS

C-2.1 The statistical concepts of accuracy (**6.2**) are illustrated in Fig. 2 which represents absolute values. It could equally have been drawn so as to show relative values relating to the setting value (relative error) or a conventional value (percentage conventional error).

Figure 2 is not intended to be an accurate or detailed representation of the errors, etc, on a single relay. In particular, and so as to simplify the diagram, the concept of confidence levels has not been fully dealt with.

C-2.1.1 *Reference Limiting Error* — The concept of 'limiting error' includes a definition of the 'risk' since it requires that sufficient determinations be made to the error as to permit an assessment of performance to be made with a given degree of confidence.

So as to avoid the need to make a statistical analysis of the errors [which, ideally, would involve an analysis of the actual data regarding the magnitude of the errors (that is, an analysis of 'variables'], it has been thought preferable to decide only whether a relay does (or does not) comply with some designated value of limiting error, this decision also being made to a given confidence level (this is referred to as inspection by 'attributes').

Either method of analysis must result in a value which will not be exceeded for more than a prescribed percentage of all relay operations (when the relay is still effectively 'new'). The recommended prescribed percentage is 4.

However, since a very large number of 'trials' would be impractical, the value will itself be subject to some uncertainty and the 'confidence level' applicable to the value must also be stated. A confidence level of 95 percent is recommended in this standard.

If the procedure of inspection by attributes is used, the corresponding acceptable quantity level (AQL) is 4, and a suitable acceptance procedure is shown in Table 7.

If some of the errors are positive and some negative (with respect to the setting), it may be necessary to take both signs into account, thus giving two values of limiting error (one positive and one negative). If only one value (for example, 'L') is stated, it is necessary to know whether the claimed tolerances are ($-0+L$), ($-L+0$) or ($+L-L$); limiting errors should therefore be stated in the form 'A—B'.

It is important for the user to note that the limiting errors may be exceeded, but that the probability of this occurring is defined.

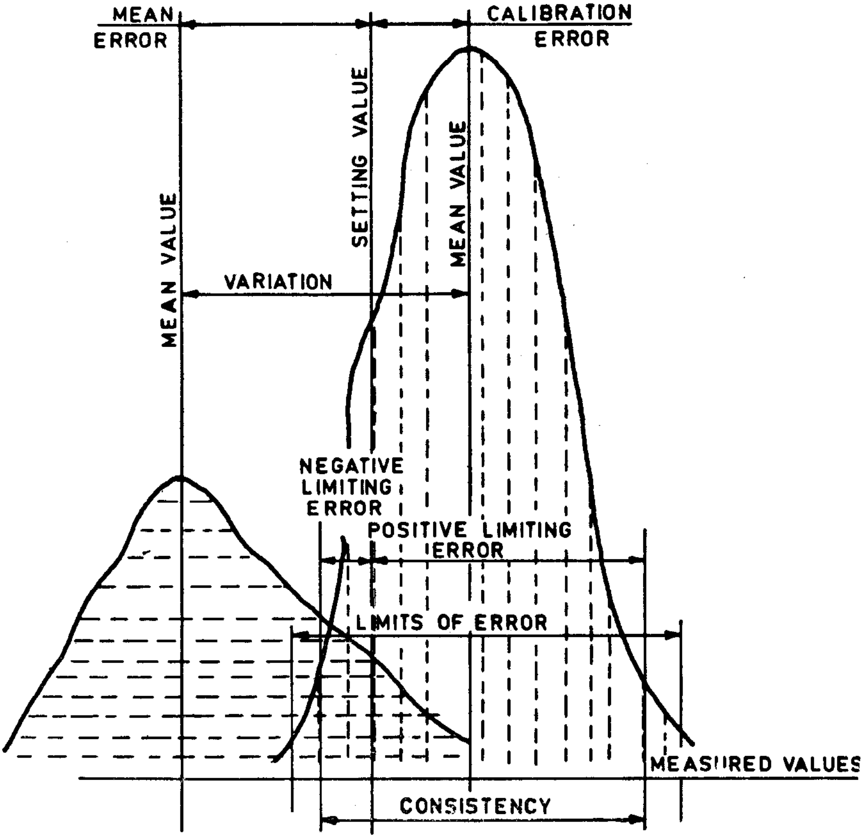

FIG. 2 MEASUREMENTS UNDER REFERENCE CONDITIONS, MEASUREMENTS WITH ONLY ONE INFLUENCING QUANTITY OR FACTOR HAVING DEPARTED FROM THE REFERENCE CONDITIONS

C-2.2 Reference Consistency — The range within which the errors will lie, depends upon natural reproducibility of relay, and the extent of this range (as opposed to the actual values of limits of range) will not be dependent upon the accuracy of any calibration marks. It is significant to the user of a relay since calibration errors may be compensated (on a relay with an adjustable) by appropriate changes in the setting value, whereas no compensation can take account of the inherent inconsistency of relay.

The consistency of a relay should be determined in the statistical manner described in **C-2.1** and the recommended confidence level applicable to the claimed range is 95 percent.

TABLE 7 ACCEPTABLE QUALITY LEVEL FOR AQL 4

(*Clause* C-2.1.1)

TOTAL NUMBER OF TRIALS	NUMBER OF OCCASIONS WHEN CLAIMED VALUE IS EXCEEDED, LEADING TO	
	Acceptance (that is, Acceptance Number)	Rejection (that is, Rejection Number)
(1)	(2)	(3)
5	Acceptance not possible	2 or more
10	0	3 or more
15	0	3 or more
20	1 or less	4 or more
25	2 or less	4 or more
30	3 or less	5 or more
35	4 or less	5 or more

C-3. VARIATIONS WITHIN THE NOMINAL RANGE OF INFLUENCING QUANTITIES (OR FACTORS)

C-3.1 If a single influencing quantity or factor is varied within its nominal range (all the others retaining their reference conditions and for a given setting value), the accuracy of a relay may change.

For example, if the ambient temperature is changed from the reference range (for example, 27°C, *see* Table 1) to either limit of its nominal range (that is, −5°C, or + 45°C, *see* Table 2), there may be a change in accuracy.

Similarly, a change in the setting value (from its reference value), may result in a change in accuracy.

Although, the change in an influencing quantity or factor may affect consistency (and, hence, limiting error) of a relay, in general, its effect on inherent (calibration) error is frequently more important and the concept of 'variations' has, therefore, been limited in this standard to this reference mean error.

A true determination of reference mean error (or, calibration error) would require a large number of measurements. For the purpose of this standard, an adequately precise value of the mean error can usually be based on ten trials.

It should, however, be noted that the estimate of mean on the basis of a relatively small number of measurements is approximate. The degree of approximation depends upon distribution of data and hence is related to consistency of relay. It follows that if a relay has a large inconsistency (that is, large range of errors), a large number of trials should be made than the ten indicated above.

It should also be noted that the estimation of a mean value requires the measurement of actual operating values and that the method of inspection by attributes will not yield data in this form.

The variation claimed for a given relay is the difference between mean error determined under the stated conditions of influencing quantities or factors and the mean error determined under the reference conditions (that is, the calibration error). There may be as many values of 'variation' as there are influencing quantities or factors, and each should be stated separately (*see* Fig. 2).